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Agency

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Environmental Fact Sheet

Partnership for a New Generation of Vehicles and the Environment

The Partnership for a New Generation of Vehicles (PNGV) is a 10-year joint research and development effort between government and industry. The Partnership was established in 1993 to develop new automotive technology. The goal is to design new technology that will help reduce air pollution by tripling the fuel economy of typical family sedans without sacrificing other important consumer attributes such as safety, performance, and affordable cost.

PNGV: New Technology for a Low-CO_2 Car

The Partnership for a New Generation of Vehicles (PNGV) was announced by President Clinton and Vice President Gore as well as the Big 3 automakers (General Motors, Ford, and Chrysler) in September 1993.

PNGV Goals

Goal 1: Improve national competitiveness in vehicle manufacturing.

Goal 2: Implement fuel efficiency and emissions technology for use in conventional vehicles.

Goal 3: Develop a vehicle to achieve up to 3 times the fuel efficiency of today's comparable vehicle.

- Design a mid-size car which gets 80 mpg.
- Do so while maintaining the size, safety, performance, affordability, and comfort of today's typical family sedan.
- Build prototype within 10 years.

The central theme of the agreement is to reconcile the automobile with the environment and at the same time, help ensure long-term competitiveness of the domestic auto industry. While today's new cars are much cleaner and more fuel efficient than those of 30 years ago, most of the advances are based on improvements to basic automotive technology invented a century ago. To achieve the ambitious goal of designing a 80-mile-per-gallon (mpg) mid-size sedan, PNGV aims to develop "leapfrog" technology rather than simply making minor improvements on today's cars. The program elevates environmental considerations to the forefront of automotive research and engineering. A successful Partnership to develop a vehicle for the 21st Century would greatly reduce the future risk of global climate change.

Cars and the Environment

Over the past century, personal vehicles (cars, minivans, sport utility vehicles, and pickup trucks) have enabled Americans to enjoy unprecedented mobility. However, this has a steep environmental cost, primarily for two major categories of air pollution: conventional emissions and greenhouse gas emissions.

Conventional Emissions

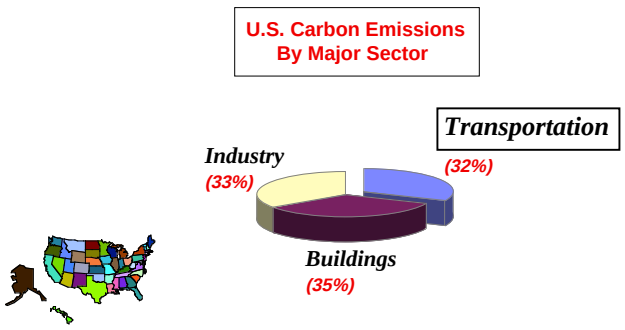
Conventional emissions refer to air pollutants known to have direct impacts on human health. These include volatile organic compounds (VOCs)—which includes hydrocarbons (HC)—as well as nitrogen oxides (NOx), carbon monoxide (CO), and particulates. VOCs and NOx together form ground-level ozone, the most serious urban air quality problem in the U.S. today. CO is a colorless, odorless gas which reduces delivery of oxygen to the body's organs and tissues. Ozone, NOx, and particulates are lung irritants and can contribute to health problems such as asthma, breathing difficulties, and bronchitis.

Greenhouse Gas Emissions

Greenhouse gas emissions such as carbon dioxide (CO_2) and methane are pollutants which can "trap" heat radiated by the earth. Many scientists believe greenhouse gases have the potential to contribute to global warming and view climate change as the most serious long-term threat to the global environment.

Transportation and Climate Change

Transportation contributes 1/3 of U.S. carbon dioxide emissions and is the fastest-growing sector



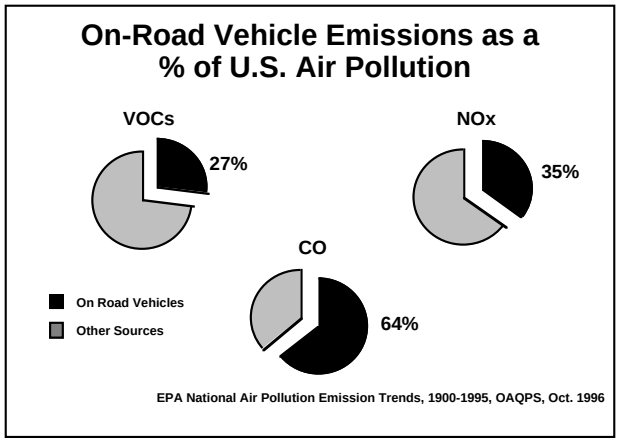
Carbon dioxide is the most important greenhouse gas and is directly related to fuel consumption. The near doubling of U.S. new car fuel economy from the mid-1970s to the mid-1980s essentially cut CO_2 emissions per car in half. Currently, transportation (cars, trucks, aircraft, marine) accounts for almost one third of U.S. CO_2 emissions and represents one of the fastest growing sectors for greenhouse emissions. Worldwide, vehicle greenhouse emission trends are also of concern. There is potential for explosive growth in developing countries as these nations develop more extensive road networks and,

like developed nations, shift toward greater use of cars to increase personal mobility.

To address global concerns on climate change, the U.S. and 160 other nations held international negotiations in Kyoto, Japan in December 1997. The nations reached agreement to reduce greenhouse gas emissions from industrialized nations below 1990 levels by the year 2012. These discussions have highlighted the need for reducing greenhouse gas emissions from motor vehicles and greatly increased the interest in highly fuel-efficient vehicles.

Vehicle Pollution and EPA

The U. S. Environmental Protection Agency (EPA) has been regulating conventional emissions like VOCs, CO, and NOx



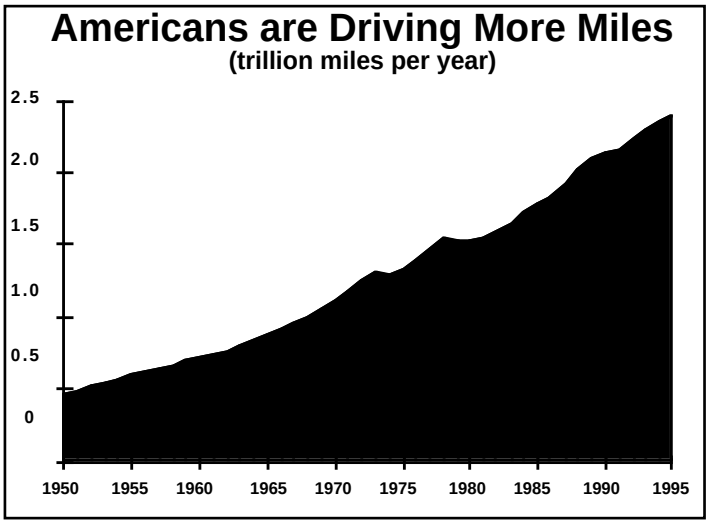
from motor vehicles since the early-1970s. Today's new cars are approximately 95 percent cleaner per mile relative to new cars of the 1960s due to technologies such as catalytic converters, on-board computers, fuel injection systems, and evaporative emission controls. Nevertheless, transportation still accounts for a large part of national air pollution. On-road vehicles alone contribute almost two-thirds of CO emissions, about a third of NOx emissions and more than a quarter of VOC emissions, nationwide. In urban areas, the contributions from on-road vehicles are even higher.

The federal government has no direct standard for CO_2 emissions from motor vehicles. However, since CO_2 emissions are a direct reflection of fuel use, programs which increase fuel economy will also limit CO_2. As part of the Corporate Average Fuel Economy (CAFE) program, the Department of Transportation and EPA have regulated vehicle fuel economy for nearly 20 years, and fuel economy levels for cars have doubled since the regulations were first established. Unfortunately, new car fuel economy has not improved for the past 10 years, so there has also been no improvement in U.S. vehicle CO_2 emissions for a decade.

Increased Driving

A central challenge in the struggle to minimize conventional and greenhouse gas emissions from cars and trucks is the growth in vehicle travel in the U.S. Even though cars produce less pollution per mile today than in the past, as Americans buy more vehicles per household and drive more miles each year, total pollution levels rise. Historically, travel in the U.S. has increased by 3 to 3.5 percent per year. This means Americans have doubled the total number of miles driven in the U.S. every 20 years! Recent growth has been about 2.3 percent per year, which would lead to a doubling in about 30 years. To keep overall vehicle pollution *constant*, cars must pollute less per mile just to

balance out the increased driving. To actually *reduce* overall pollution, emissions per mile must be cut significantly. While tighter EPA vehicle standards for conventional emissions have helped offset increased driving, CO_2 control has not kept pace.



Increased CO_2

Unfortunately, in the U.S., several major trends suggest CO_2 emissions from personal vehicles will continue to rise. These trends include:

- steady annual increases in driving over the last 50+ years;
- inflation-adjusted gasoline prices near all-time low;
- little consumer interest in fuel economy relative to performance, size, utility, and comfort;
- the consumer shift from cars toward larger minivans, sport utility vehicles, and pickup trucks which consume more fuel and therefore emit more CO_2; and
- little consideration of truly renewable fuels for transportation.

Environmental Benefits of PNGV

By tripling the fuel economy rating of a typical midsize car from around 27 mpg to 80 mpg, PNGV offers a great environmental reward. This fuel economy improvement not only reduces a vehicle's fuel consumption by 67 percent but also creates the equivalent reduction in automotive CO_2 emissions. For example, a vehicle certified at 80 mpg would emit just 112 grams of CO_2 per mile—one third the CO_2 produced per mile by a typical car today. (Actual values will be slightly higher in on-road driving.) This has ground-breaking implications since technology developed in the U.S. could be applied worldwide to reduce greenhouse gases.

None of the other major public policy options for reducing automotive CO_2 emissions—higher gasoline taxes, higher fuel economy standards, renewable fuel requirements, or travel restrictions—is politically popular. New technology that avoids major trade-offs offers an attractive path toward CO_2 emission reductions from vehicles. A program like PNGV could play a major role in any U.S. climate change strategy.

At the 1998 Detroit Auto Show, automotive manufacturers showcased a number of high-efficiency concept vehicles which utilize the same types of technologies

being researched through PNGV. These vehicles, along with manufacturer announcements during the Auto Show, indicate both that research on high efficiency vehicles is well underway, and that one or more of these technologies will likely be technically feasible in the PNGV time frame.

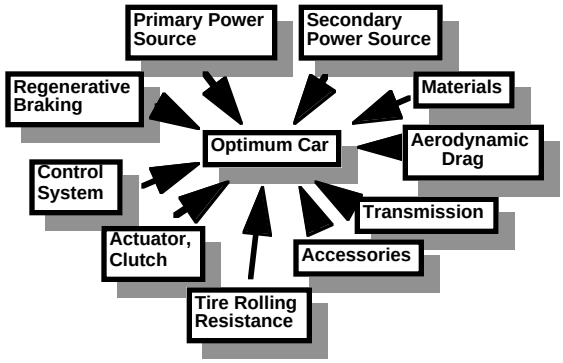
In order to successfully meet the 80-mpg goal of PNGV, a prototype vehicle must demonstrate that it can meet even tighter Tier 2 vehicle emission standards. The Tier 2 program was authorized by Congress in the Clean Air Act Amendments of 1990, which instructed EPA to determine whether tighter standards for conventional pollutants are necessary in order to protect air quality. The Act suggested EPA consider reducing current standards for HC, CO, and NOx by a factor of two and increase the definition of a vehicle's "useful life" from 50,000 to 100,000 miles, thereby keeping vehicles cleaner, longer. Having a PNGV vehicle meet these tighter emission levels represent a significant step forward in terms of lower emissions. It ensures successful PNGV technologies will create not only the most fuel efficient but also some of the cleanest personal vehicles in the world.

In addition, PNGV could yield several other environmental benefits since the amount of oil exploration, drilling, shipping, and refining would drop as fuel consumption declined. Finally, the PNGV program has established a goal of at least 80 percent recyclable components, another step beyond today's industry average of about 75 percent.

PNGV Advanced Technology Research

The triple fuel economy objective involves a long-term systems approach. Many different technologies are now under consideration, and it is impossible to predict which of these technologies will turn out to be the winner or, hopefully, winners.

Building the Optimum PNGV Car



Research on new PNGV automotive technologies has been active at federal agencies, national research labs, automotive suppliers, universities, and private industry since PNGV was announced in late 1993. In January 1998, PNGV announced the selection of technologies considered to be among the most promising to meet the goals for an 80-mpg PNGV vehicle. The four areas highlighted by the Partnership include the following:

Priority Research

• **Advanced direct injection engines**: Researchers are studying piston engines that incorporate advanced technology features such as direct injection, turbocharging, multiple valves per cylinder, lightweight materials, and novel methods

of construction. Engines that are derived from small diesels using conventional fuels are receiving much interest, especially with respect to NOx and particulate emission control approaches. Other fuels are also being investigated.

• **Fuel cells**: This power source is a substitute for the conventional internal combustion engine in cars today. Fuel cells convert hydrogen into electricity in a simple system with no moving parts. In an ideal system, the only by-product is water vapor, and there is no other pollution. The hydrogen used by fuel cells can be stored directly (e.g., compressed in a tank) or manufactured on-board from a fuel like methanol.

• **Hybrid-electric vehicle drive:** Hybrid vehicles typically combine two different types of power sources in a single vehicle to take advantage of the unique benefits of each source. PNGV researchers have focused on both diesel-electric hybrids, which would have both a diesel engine and a battery, and gasoline-electric vehicles, which would have both a gasoline engine and batteries. Batteries vary in the amount of driving range they allow a vehicle based on their energy and power densities and their charging/discharging efficiencies. Most electric vehicles in the past century have used lead-acid batteries, but researchers are developing advanced batteries such as nickel-iron, nickel-cadmium, sodium-sulfur, zinc-air, and lithium batteries, among others.

• **Lightweight materials**: Recent advancements in strong, lightweight materials for use in vehicles offer another way to reduce fuel consumption while maintaining safety and performance. Research on advanced applications of aluminum, plastics, and composites has also stimulated vehicle weight reductions using more conventional materials.

In addition to these areas of focus, the Partnership has also been investigating many other promising technologies, including:

Power Sources

• **Gas turbines**: Both metallic and ceramic types of gas turbines are under consideration. There is also interest in configurations which integrate the prime engine mover and an electrical motor/generator.

• **Flywheels**: Energy is stored and released in a flywheel system by the increase and decrease of the rotational speed. Advanced materials with high strength-to-weight ratios are under consideration as are configurations in which the flywheel is integrated into the motor/generator. Like other secondary power sources, cost, reliability, efficiency, and safety need to be assessed fully.

• **Ultracapacitors**: Ultracapacitors are devices for storing electricity like a battery. Unlike a battery, however, they are designed to release their energy in a quick burst (ideal for starting or accelerating a car) and they store energy quickly (ideal for capturing the energy available when a car is braking). Current work is concentrated on improving performance and reducing costs.

• **Hydropneumatics**: This is a mechanical type of energy storage. Hydro-pneumatic systems store energy by using a high-pressure liquid to compress gas. These systems have high power densities

(which allow a quick burst of energy, ideal for vehicle acceleration) but have low energy densities (meaning they only store a small amount of energy.)

Reducing Energy Demand

• **Aerodynamic drag**: Aerodynamic drag is a measure of the resistance caused by air as vehicles are driving. Drag increases in proportion to the vehicle's speed squared and depends on the size and shape of the vehicle. Most efforts are going into vehicle drag coefficient studies since researchers are not expected to reduce the frontal area for the PNGV car.

• **Tire Rolling Resistance**: Tires vary in the amount of friction they must overcome as they roll. While friction can help with driving traction, it also forces a vehicle to use more fuel to overcome the friction forces. Advanced tires with low rolling resistance are designed to be more efficient while maintaining safety and performance.

• **Accessories**: Any use of accessory devices on a car or truck—air conditioning, heaters, radios, lights, etc.—consumes additional fuel. Current research is examining ways to make accessories more efficient while also exploring alternative ways of powering these components.

Reducing Energy Losses

• **Regenerative Braking:** One way to reduce the amount of energy it takes to drive a car is to save the energy usually dissipated as heat during vehicle braking and use it to help power the car instead. This "regenerative braking" will use the types of secondary power sources discussed previously to store and release this otherwise-wasted energy.

• **Other Losses**: Consideration is also being given to the possibility of recovering some of the energy now lost as heat in engine coolant and engine exhaust and using it to help power the vehicle.

Alternative Fuels

Nonpetroleum fuels provide alternative sources of energy to traditional gasoline and diesel fuels. Promising alternative fuels now used to power vehicles include compressed natural gas, methanol, ethanol, propane, dimethyl ether, hydrogen, and electricity. Some of these can be produced by renewable and/or domestic resources such as wood, corn, or even garbage. Renewable fuels have the potential to provide additional greenhouse emission reductions even beyond fuel economy advancements, particularly if farmers and fuel producers use renewable energy—rather than fossil fuels—to power equipment used in harvesting, transporting, and producing renewable feedstocks and renewable fuels.

For More Information

For further information on the PNGV program, please contact the Advanced Technology Support Division at:

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Additional documents on PNGV are available electronically from the EPA Internet server at:

http://www.epa.gov/OMSWWW/pngvhome.htm